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PRELIMINARY RESULTS OF MEASUREMENTS OF SQ CURRENTS AND THE EQUATORIAL ELECTROJET NEAR PERU

by

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Preliminary Results of Measurements of SQ Currents and the Equatorial Electrojet near Peru

Four Nike-Apache sounding rockets were launched from the USNS Croatan during March, 1965, to measure electrical currents in the ionosphere. These flights off the coast of Peru were part of the recent NASA Mobile Launch Expedition. Preliminary magnetometer results from two of these flights are of interest in establishing the characteristics of the equatorial electroject (Singer et al, 1951; Cahill, 1959; Maynard et al, 1965; Maynard and Cahill, 1965), and of the low altitude SQ current system (Burrows and Hall, 1965; Davis et al, 1965).

The rockets were instrumented to measure the magnetic field and the electron density. A nuclear free precession magnetometer measured the scalar magnitude B of the earth's magnetic field, and a DC Langmuir probe was used to measure the relative electron density. These instruments have been described earlier (Maynard and Cahill, 1965). Also included in the payload for trajectory and aspect determinations were a barometric pressure switch, an ionization chamber densitometer to monitor air pressure, and a magnetic aspect sensor. An FM-FM telemetry system transmitted the signal to the ground, where it was recorded with a 100 kc reference signal for later data processing.

Flight UNH 65-5 (NASA 14.82 UE) was launched from the

Croatan at 1100 hours local time on March 12, 1965, from 11° 25' south latitude and 81° 20' west longitude near the geomagnetic dip equator and near the center of the electrojet. The trajectory was computed to fit the baro-switch operation times at 70,000 feet. Peak altitude was calculated to 173 km. From radar plot board data for the first minute of flight, an estimate of range was made, and the theoretical field was computed over an approximate trajectory, using the coefficients of Leaton and Evans (private communication).

Figure 1 depicts the difference between the measured field and the computed field, plotted as a function of altitude. The slope starts to change about 95 km, and the maximum current appears to be located at 108 km. The current layer extends upward with decreasing intensity to about 130 km in similar manner to that observed by Maynard and Cahill (1965) over India. The total change in field is about 120 gammas, in comparison with 60 to 70 gammas for the mid-day India flights. On the downward leg the current is centered near 108 km. The long sloping tail above 130 km on the downward leg is believed to be the result of inaccuracy of the preliminary trajectory used in calculating the theoretical field. The gradual rise above 140 km on the upward leg is also attributed to this factor. The wide fluctuations below 85 km on the downward leg were apparently caused by overturning of the rocket spin axis, as they are correlated with similar fluctuations in the signal from the magnetic aspect sensor.

Flight UNH 65-2 (NASA 14.85 UE) was launched at 1136 hours local time on March 9, 1965, from 3° 07' south latitude and 84° 22' west longitude. This was more than 8° north of the magnetic dip equator, hence well to the north of the equatorial electrojet, which is estimated to be 6° wide over Peru (extending 3° north and south of the dip equator, Forbush and Casaverde, 1961). For initial analysis, time of peak altitude was taken as the time of minimum magnetic field. The radar tracking data in the early portion of the flight were also used in computing a trajectory. Peak altitude was determined to be 161.8 km. The theoretical field was computed over an approximate trajectory, using the same range as established for 65-5 and using Leaton and Evans coefficients.

The difference between the measured field and the theoretical field is shown in Figure 2. Many of the small variations observed are apparently due to precession of the rocket with a field of about 3 gammas. The arrows over the curves denote the time of maximum positive effect of the precession, while the arrows under the curves denote the maximum negative effect. These times were taken from the precession record obtained from the magnetic aspect data. The SQ current measured is more diffuse than the electrojet, extending from 93 km up to about 130 km (upward leg data). The shift downward in altitude of this effect on the downward leg is thought to be due to preliminary trajectory errors. The change of slope between 105 and 110 km on the upward leg (100 and 105 km on the downward leg), apparently is not due to precession and suggests a double-layered current structure with the peak of the lower layer at 100 km and of the upper layer at 118 km (upward leg data). Total magnetic change due to the current layers was about 45 gammas. The two points which widely deviate from the curve on the upward leg are believed to be the result of noisy magnetometer signals. The fluctuations below 65 km on the downward leg are again due to overturning of the rocket spin axis.

Magnetograms for the two flight days from the Peruvian stations at Huànuco, (9.9° South; 72.9° West), and Cañete (13.1° South; 76.4° West), are shown in Figure 3 (records provided by Scott Forbush of the Carnegie Institute of Washington, Department of Terrestrial Magnetism). Launch times of the two flights are indicated on the appropriate magnetograms. These stations are respectively above and below the electroject center, as is apparent by the Z component variation. The Huàncayo record, closer to the electroject center, is not yet available to us, so detailed comparison of the rocket and ground results will not be attempted here. It is apparent, however, that the rockets were launched near the peak of the diurnal variation on each day, and that the earth's magnetic field was reasonably quiet.

Further analysis of these two flights and of the other two (March 10, 1965, at 1100 hours, 6° 30' South; 84° 32' West; March 12, 1965, at 0830 hours, 11° 23' South, 81° 25' West) is now in progress and will be reported in detail in a later paper.

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Captions

Figure 1. The difference between the measured field and the calculated field, plotted against altitude for UNH 65-5.

Figure 2. The difference between the measured field and the calculated field as a function of altitude for UNH 65-2. The arrows above the curves denote maximums in the effect from rocket precession, while those below the curves indicate minimums.

Figure 3. Magnetograms from the magnetic observatories at Huànuco and Cañete in Peru, for the days of the two launchings. Time of launch for each flight is denoted on the respective magnetogram.

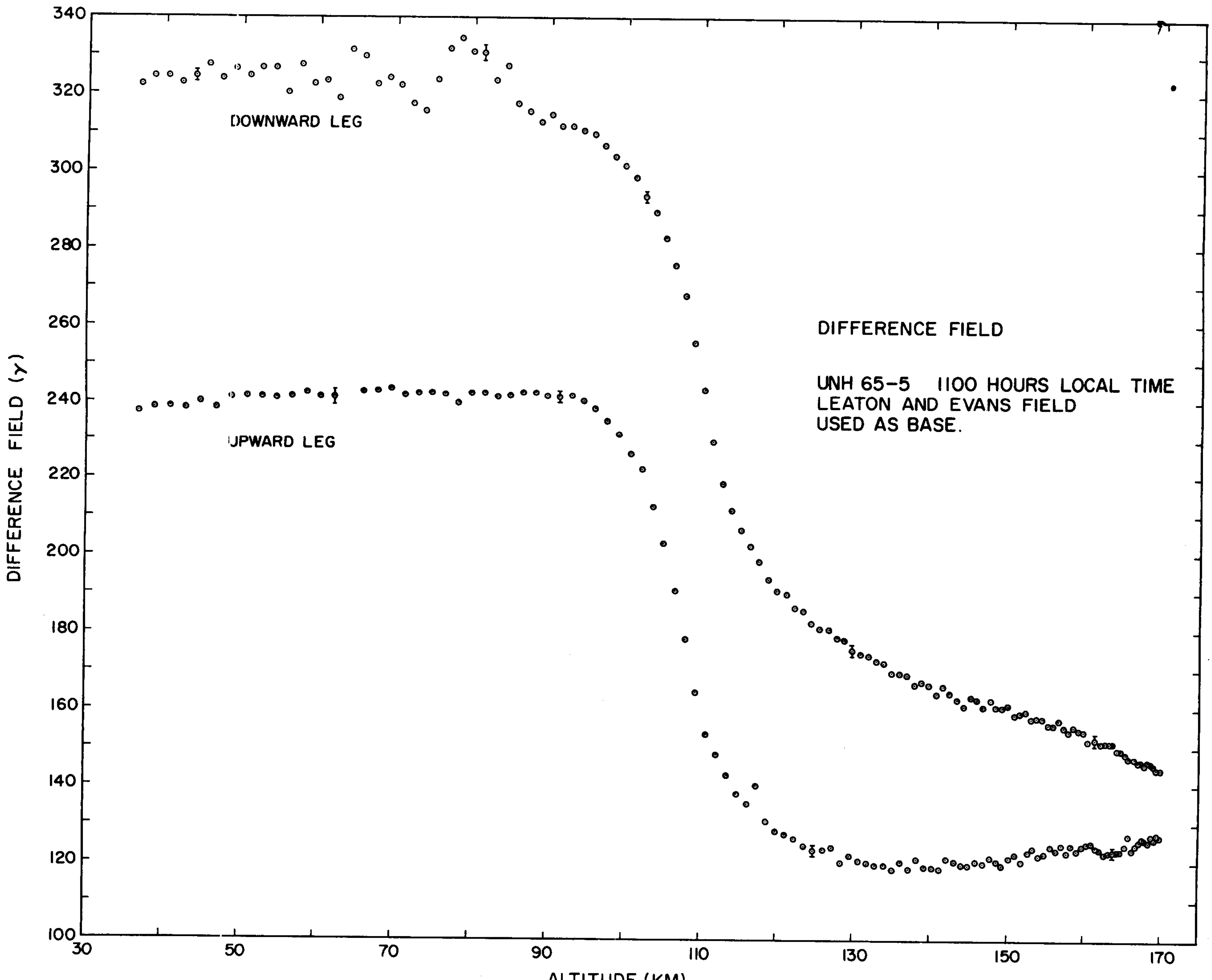
DIFFERENCE FIELD
UNH 65-5 1100 HOURS LOCAL TIME
LEATON AND EVANS FIELD
USED AS BASE.
DOWNWARD LEG
UPWARD LEG
DIFFERENCE FIELD (γ)
ALTITUDE (KM)
340
320
300
280
260
240
220
200
180
160
140
120
100
30
50
70
90
110
130
150
170

Figure 1

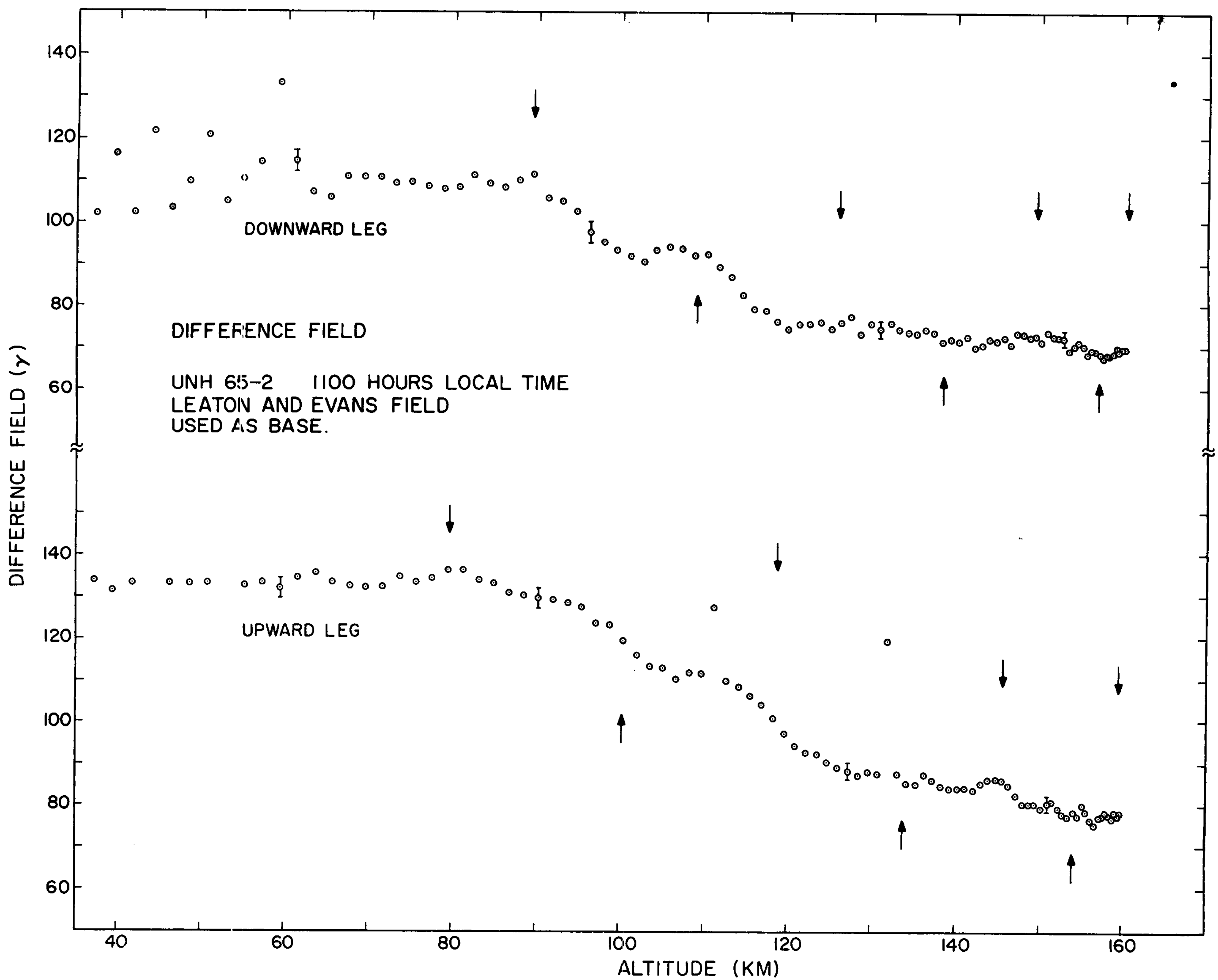
DOWNWARD LEG
DIFFERENCE FIELD
UNH 65-2 1100 HOURS LOCAL TIME
LEATON AND EVANS FIELD
USED AS BASE.
UPWARD LEG
DIFFERENCE FIELD (γ)
ALTITUDE (KM)
140
120
100
80
60
40
160

Figure 2

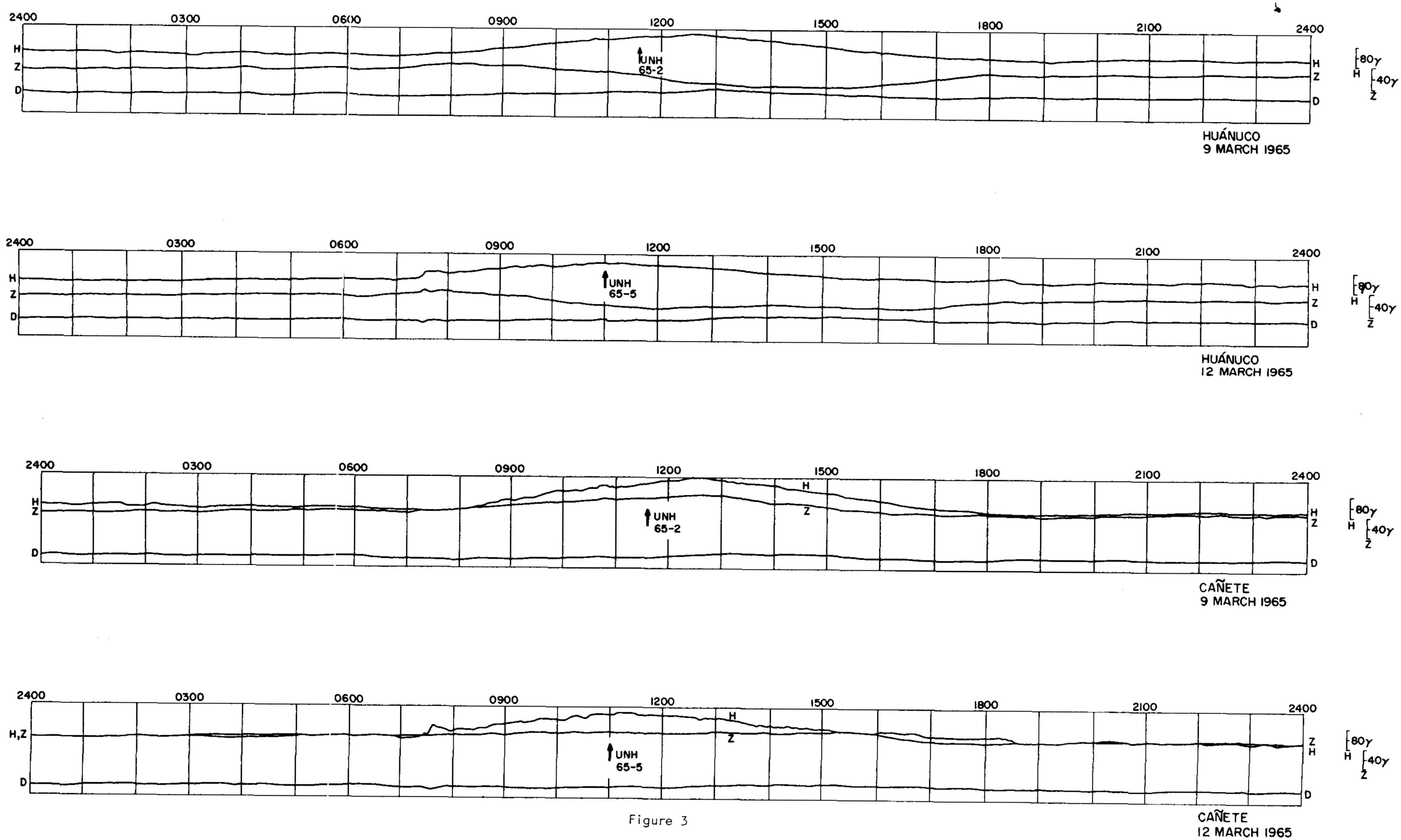
2400
0300
0600
0900
1200
1500
1800
2100
2400
H
Z
D
UNH
65-2
80γ
40γ
HUÁNUCO
9 MARCH 1965
UNH
65-5
HUÁNUCO
12 MARCH 1965
CAÑETE
9 MARCH 1965
H,Z
CAÑETE
12 MARCH 1965

Figure 3